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Structure Design and Application of Combination Track Intelligent Inspection Robot Used in Substation Indoor

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Abstract

In order to solve the problems of substation indoor inspection, a kind of combined track intelligent inspection robot was proposed in this paper, and the main structure, working principle and control system were introduced. Then a combination of linear planning algorithm was performed. Finally the field application in substation water cooling room was made, and the result shows that the robot can meet the requirements of field inspection.

Keywords: substation; indoor; combination track; inspection robot; design

1. Introduction

The security and stability of substation indoor equipment (such as valves room, switchgear room, GIS room, capacitors room, relay room, water cooling room) are key factors to ensure the normal operation. And the operators have to make an accurate and comprehensive understanding to the equipment running state in case of the potential danger^[1-3], such as regular inspection^[4]. But there usually remains a relatively large of security risk even when the switch was pulled off. Furthermore, the manual inspection data cannot be access to the information management systems accurate and timely, which has a big influence to the power grid automation and intelligence. These problems are particularly prominent to unmanned substations. Multiple fixed point monitoring are general used for the indoor device inspection. But it exist some blind spot detection and cannot meet the requirements of full coverage^[5].

With the development of robot and artificial intelligence technology, the use of indoor track smart detection system has become possible. Shenzhen Launch Digital Technology Co Ltd., Shenyang Institute of Automation Chinese Academy of Sciences, Liaoning Anshan Electric Power Company, and Beijing ZD Golden Bridging &

Technology Development Co, Ltd, Ltd. have developed several different types of orbital inspection robot [6-8]. However, they have not been applied in large scale due to the factors such as the track type, the inspection requirements, the robot weight and the equipment height. Maintenance Branch of Ningxia Subsidiary of State Grid and Shandong Luneng Intelligence Technology Co. Ltd. have conducted a preliminary study on the indoor track robot since 2014, and linear orbit robot , valves room intelligent inspection robot were developed and took into use^[1,2,9].

This research of indoor track type inspection robot has been carried out in domestic, but it still stays in the initial stage. And the current indoor inspection robots are difficult to achieve the inspection of higher equipment and the area above the equipment. In this case, the technology research of indoor track intelligent inspection system is particularly urgent.

Based on these considerations, an indoor inspection robot was proposed in this paper and it can achieve three directions' movement (X , Y and Z). The robot can complete the Omni-directional inspection of the substation indoor equipment by carrying the necessary device, which can improve the inspection coverage rate and the intelligent level of power grid.

2. The overall structure and main technical parameters

2.1 Overall structure

The robot system consists of a track robot and background monitoring components, wherein the robot includes combined orbit driving system, detection system and body, which is shown in Fig. 1. The robot adopts the sliding contact line and power line carrier communication technology, which can achieve the 24 hours continuous work and meet the requirements of some substation indoor rooms prohibited wireless communication.

The combined orbit drive system includes two fixed tracks (X axis), a moving track (Y axis), and synchronous axis. Wherein one X axis and Y axis are independent linear drive unit (including the motor, reducer, drive belt, rail and sliding device), the other X axis is the slave unit (including the rail and sliding device). Y axis and the synchronous axis are fixed together in order to increase the stiffness. The robot is fixed on Y axis sliding device and the synchronous axis is fixed on the X -axis sliding device. X axis were mounted on the ceiling or interior beams by fixed brackets. The robot body is a bamboo lift structure (Z axis), which can run through the top of the indoor equipment after shrinking.

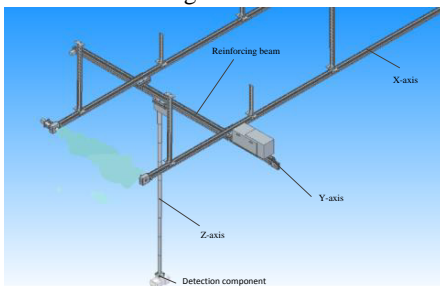


Fig. 1 (a) Structure schematic diagram



Fig. 1 (b) Field application

Fig.1 The installation diagram of indoor inspection robot

2.2 Working principle

The power of X axis drive motor passes from the reducer to the drive belt, and then to X -axis sliding device, thereby Y axis can run along X axis. In the same, the power of Y -axis drive motor passes from the reducer to the drive belt, and then to Y axis sliding device, thereby Z axis can run along Y axis. And Z axis begins to run after X axis and Y axis finish their movements respectively. Combined the movements of X axis, Y axis and Z axis, the robot can move in the entire space and reach every corner of the room.

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